A Preliminary Assessment of Disturbance to Rock Outcrops in Gibraltar Range National Park

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The significance of habitat disturbance within protected areas remains poorly understood. This study assessed habitat disturbance to granite rock outcrops within a protected area in north-east New South Wales. Survey sites were classed as near (<350 m) or far (>500 m) from roads and walking tracks. Habitat disturbance was dependent on site category, occurring at 8 of 10 near sites compared to 1 of 12 far sites. Disturbance mostly consisted of the construction of rock cairns that may deplete the availability of loose rocks at a site. Reptiles were frequently found sheltering under loose rocks, attesting to the valuable microhabitat that this type of substrate provides. Further research is required to understand the significance of this disturbance and the extent of dependence by the local reptile fauna on this substrate. Our data provide a baseline against which future surveys can be compared.

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INTRODUCTION

A common assumption in developed countries is that species and their habitats contained within protected areas will be adequately conserved (e.g. Primack 1998; Brooks et al. 2004; Higgins et al. 2004; Molnar et al. 2004). Indeed, much effort and many resources have been put into expanding protected area networks to extend such protection, particularly in New South Wales (Davey et al. 2002; Pressey et al. 2002; Newell and Goldingay 2004). Many protected areas are managed specifically for recreational use. Where this occurs management is often focused on minimizing the impacts of users in areas where recreational activities are concentrated (e.g. NPWS 2000a,b). However, recognition is emerging that protected area users may diminish the quality of some wildlife habitats over broad areas (Goldingay 1998; Newell and Goldingay in press).

One important case study that implicates protected area users in the widespread degradation of wildlife habitat is that of the broad-headed snake (*Hoplocephalus bungaroides*). This endangered species has a geographic range completely restricted to the Sydney basin (Swan 1990; Cogger 1992), where it shelters within sandstone rock outcrops during the cooler months of the year (Webb and Shine 1998). It is known from a number of protected areas and its conservation appears dependent on how well these areas are managed (Cogger et al. 1993). Several studies have demonstrated that disturbance to rock outcrops is widespread and continuing to threaten this snake (Schlesinger and Shine 1994; Goldingay 1998; Shine *et al.* 1998; Goldingay and Newell 2000; Webb *et al.* 2002). Until recently, collection of sandstone bush-rock for landscaping from protected areas was viewed as the primary cause of the decline of this species (Hersey 1980; Shine and Fitzgerald 1989; Mahony 1997; Shine et al. 1998). It is now recognized that much of this disturbance can be attributed to protected area users, of which there appear to be three types involved: hikers, reptile poachers and vandals (Goldingay and Newell 2000; Newell and Goldingay in press).

Whilst concern about rock habitat degradation in Australia has been driven by its impact on the broad-headed snake, this is not the only species that is affected (see Schlesinger and Shine 1994). For example, Newell and Goldingay (in press) detected a further 19 reptile species under loose rocks (eight

1a

1b

Figure 1. (a). Granite outcrops near the Waratah Trig. (b). Anvil rock showing associated outcrop.

snakes, three geckos, seven skinks and one dragon) during a regional survey for the broad-headed snake. Rock crevices are commonly used as retreat sites by many species of reptile and frog, some of which may be dependent on such habitat during periods of the year and are likely to be affected by rock habitat degradation. Furthermore, there is no reason to expect that this kind of habitat degradation will be limited to sandstone substrates. Therefore, there is a need to conduct studies at many locations to assess how ubiquitous rock habitat disturbance may be. Indeed, Goode et al. (2005) have identified that destruction of rock habitats is widespread in parts of the USA and was associated with a decreased abundance of rock-dwelling reptiles.

The aim of this study was to provide a preliminary assessment of rock habitat disturbance in Gibraltar Range National Park. This protected area occurs in north-eastern New South Wales and is characterized by many areas of distinctive granite rock formation that have associated rock outcrops.

METHODS

Study Area

Gibraltar Range National Park (Gibraltar Range NP) is located approximately 100 km west of Grafton. It has an area of approximately 25,000 ha and is bounded to the north by Washpool National Park, which is 67,000 ha (NPWS 2003). These parks are included in the World Heritage area known as the Central Eastern Rainforest Reserves of Australia (DEC 2005).

Gibraltar Range NP contains broad areas of rainforest, heathland, open forest and woodland. Rainforest is common along the eastern and northern sides of the Park while open forest occurs through much of the remainder of the Park. Heathland areas are restricted in area and are associated with drainage lines that traverse the Park. Granite rock outcrops are widespread through the Park (Fig. 1). A wildfire burnt through much of the Park in December 2002.

Survey Sites

Areas of rock habitat suitable for survey were identified from topographic maps and from ground truthing. Only areas with a north through west aspect were included in the survey because these aspects are more highly preferred by reptiles that rely on sheltering under loose rocks (Webb and Shine 1998; Pringle et al. 2003). If outcrops with these aspects were affected by habitat disturbance then others would be also. Sites were purposefully selected to fall into one of two categories: either near (<350 m) or far (>500 m) from a road or walking track. Sites had to be at least 250 m apart to be considered as individual sites. Sites were selected in the vicinity of the Waratah Trig (located either side of the boundary between Gibraltar Range NP and Washpool NP) and the Anvil Rock (Gibraltar Range NP) walking tracks (see Table 1 for location details).

We selected rock platforms that contained at

Figure 2. (a). A rock cairn, showing stencils left when rocks have been moved from their original position. (b). An older rock cairn.

least 10 loose rocks along a 50 x 20 m transect. This provided a reasonable minimum number of rocks from which to determine whether any disturbance had occurred. Only rocks >10 cm in length were included in the assessment. Once a site was selected, all loose rocks along the transect were counted and inspected for evidence of disturbance (e.g. rock cairns, rock camp fires, rocks flipped over). Rocks were lifted to determine their suitability to provide habitat for reptiles. This was ascertained by scoring whether rocks sat neatly on the platform, whether they formed a narrow crevice with the platform and whether at least 50% of the underlying substrate consisted of bare rock (Goldingay 1998; Newell and Goldingay in press). Such rocks were classed as "good" rocks for reptile use and counted. Any sheltering reptiles were identified. Most transects were surveyed by two people. If no evidence of disturbance was obtained on a transect, then a search for disturbance was also conducted of areas within a 50 m radius of the transect. This was simply a recognition that disturbance may be patchy and that transects may be too short to adequately sample an area. Each site was surveyed on one occasion in March 2005.

RESULTS

Of 22 sites chosen for survey, 10 occurred near and 12 occurred far from roads and tracks. Eight of the near sites showed some evidence of disturbance compared to one of the far sites (Table 1). For one near site, no disturbance was found on the transect but a rock cairn was observed within 50 m of the transect. This distribution of disturbance across sites shows that disturbance was highly dependent on site category (G = 12.88, P=0.001). Disturbance consisted of rock cairns (Fig. 2), fireplaces (Fig. 3) and less commonly a broken or flipped over rock. The one instance of rock disturbance at a far site was a single rock (ca 35 x 42 cm in size) that had been flipped over to reveal a stencil from where it rested originally (Fig. 4). There were no other rocks around this site that showed evidence of disturbance.

There was a significant difference (t = 2.50, P = 0.021) in the total number of rocks counted along near (27.7 ± 3.2) versus far (38.6 ± 2.9) transects. When only good rocks is considered, there was no significant difference (t = 1.16, P = 0.26) in the number of rocks counted along near (5.0 ± 1.0) versus far (7.3 ± 1.2) transects.

Due to the time of year when surveys were conducted (autumn), only a small number of reptiles was observed sheltering under loose rocks. *Eulamprus tenuis* was the most common species, being detected at 11 of the sites (4 near, 7 far). Mcphee's skink (*Egernia mcpheei*) and White's skink (*Egernia whitii*) were observed at two sites. Cunningham's skink (*Egernia*

Table 1. Survey site details and reptiles detected under rocks. AMG = Australian Map Grid references (Eastings, Northings). Near sites were located <350 m from a walking track or road, while far sites were located >500 m from these. Rocks are the number of rocks along a 50 x 20 m transect. Good is the number of rocks with traits most suitable for use by reptiles. Reptiles: Et = *Eulamprus tenuis*; Em = *Egernia mcpheei*; Ew = *Egernia whitii*; Ec = *Egernia cunninghami*; Bp = *Bassiana platynota.*

Site	AMG reference	Distance (m)	Rocks	Good	Reptiles	Types of Disturbance
1	0433091 6736800	Near (50)	29	5	-	Cairn (of 3 rocks), broken rock, displaced rock
2	0433091 6736839	Near (20)	42	3	-	Cairn (of 12 rocks)
3	0432567 6736726	Near (200)	36	5	2 Et	Cairn outside transect only
4	0433539 6737182	Near (150)	27	3	3 Em	None
5	0433761 6737538	Near (50)	24	4	1 Et	Broken rock
6	0434263 6737888	Near (20)	12	2	-	3 cairns (13, 15,16 rocks)
7	0433590 6730564	Near (100)	41	6	6 Et	Fire place, rock seat, 2 cairns (3, 3 rocks)
8	0433556 6730491	Near (300)	31	13	1 Et, 2 Ew	None
9	0430090 6732380	Near (50)	16	3	-	Fireplace, broken rock
10	0429603 6732331	Near (200)	19	6	Ew	Cairn
11	0432309 6736252	Far	41	3	1 Bp	None
12	0432232 6736539	Far	29	5	3 Em	None
13	0432268 6736821	Far	43	11	-	None
14	0432140 6737080	Far	46	1	1 Et	None
15	0432161 6737590	Far	41	10	-	None
16	0432542 6737299	Far	26	5	1 Et	1 flipped rock
17	0432776 6737429	Far	27	7	-	None
18	0433024 6737329	Far	30	3	1 Et, Ec	None
19	0433834 6730303	Far	40	10	2 Et	None
20	0433924 6730049	Far	31	7	1 Et	None
21	0434210 6730149	Far	51	12	3 Et	None
22	0434288 6730664	Far	58	14	2 Et	None

cunninghami) was seen in a number of rock crevices at various sites but was recorded under loose rocks at only one site. There was no difference (t = 0.39, P = 0.35) in the mean number of lizards per site (near: 1.6 ± 0.6; far: 1.3 ± 0.3) across site categories.

DISCUSSION

This study has provided some important insights that will extend our understanding of habitat disturbance within protected areas. We detected

Figure 3. Granite rocks used to form a bush campfire.

Figure 4. A rock that has been flipped over at the far site. Two coins (20 cent, one dollar) are present near the stencil for scale.

evidence of rock habitat disturbance at many sites and this showed a highly significant association with whether sites were near or far from tracks or roads. This finding is consistent with what we have observed in rock habitats around Sydney (Goldingay 1998; Goldingay and Newell 2000; Newell and Goldingay in press). There is clearly an influence of distance from access points on the likelihood that disturbance will occur. This provides Park managers with a clear insight for managing rock habitats. That is, areas within 500 m of existing tracks are likely to be associated with disturbance, and development of new walking tracks will attract habitat disturbance.

In the present study, most disturbance consisted of rock cairns and fireplaces that had been constructed by hikers. In contrast, most of the rock disturbance observed in Sydney was caused by vandals and reptile poachers, and led to severe habitat degradation (e.g. rocks were often smashed). We found almost no evidence of rock disturbance consistent with searching for reptiles. The one observation of a rock that was overturned was quite isolated, unlike that in protected areas near Sydney where several rocks in an area show evidence of such disturbance (Goldingay and Newell unpubl. data). Therefore, we conclude that the overturning of this one rock was likely caused by a hiker rather than by someone searching for reptiles.

This study provides a useful baseline for a protected area in which reptile poaching is currently of low significance. It is unknown whether this is due to the Park's relative isolation, away from a large city, or because it lacks an endangered species that might be targeted by reptile poachers. However, follow-up surveys in another 5-years time would be a worthwhile management consideration to ensure that rock habitat disturbance remains at a low level. Surveys of similar habitat in other Parks in north-east NSW should be conducted to establish a baseline of data for many further areas. It is likely that rock habitat disturbance is widespread, though possibly different in intensity to that seen in the Sydney basin (see Shine et al. 1998; Newell and Goldingay in press).

Rock cairns were quite common, occurring at 6 of 10 near sites. Indeed, the walking track to the Waratah Trig was marked by >30 small rock cairns for most of the distance (see Fig. 5). It is not clear whether any of these were recent but it highlights an issue that the impacts of this activity are not well

Figure 5. Rock cairns marking the track on the way to the Waratah Trig.

understood. The plan of management for Gibraltar Range and Washpool NPs notes that among several objectives, "National Parks are managed to provide for sustainable visitor use and enjoyment that is compatible with conservation of natural and cultural values" (DEC 2005). It is unlikely that the habitat disturbance identified in this study is compatible with the conservation of natural values based on studies of rock habitat disturbance in the Sydney basin (Shine et al. 1998; Goldingay and Newell 2000) and the thermal requirements of rock-dwelling reptiles (e.g. Webb and Shine 1998). Providing education to the general public may be needed to mitigate habitat impacts. The on-going need for this could be assessed by photographic monitoring of a number of near sites over several years to assess whether rock cairns and rock campfires are continuing to be constructed. Such an assessment was used successfully by Goldingay and Newell (2000) in Royal National Park in Sydney to monitor rock disturbance. This would be consistent with the identified need for research into visitor-use impacts in these Parks.

We found significantly fewer rocks on near transects compared to far transects. This is consistent with the greater frequency of disturbance on the near transects. This may have little consequence for rock-dwelling reptiles because the number of rocks suitable for use by reptiles did not differ across site categories. The number of reptiles across sites was not different. However, the time of the survey was not optimal for assessing the number of reptiles that use loose rocks and it is likely that some species are more sensitive to disturbance than others. Surveys conducted during late winter would be more appropriate (see Newell and Goldingay in press). It would be worthwhile for a detailed study to be conducted so that species that are highly dependent on the loose rocks in rock outcrops can be identified and their management needs better understood.

This study highlights that disturbance to loose rock habitats is not confined to areas around Sydney. We could generalize from this study that such habitat disturbance is a widespread phenomenon regardless of where that rock habitat occurs. Goode et al. (2005) have revealed that it occurs in many rocky habitats in arid areas of the USA. Understanding the ecological significance of such habitat disturbance will depend on understanding the number of species that are dependent on rocky habitats.

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